The Sudbury Neutrino Observatory ^{16}N β-decay Energy Calibration Source

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The primary energy calibration source for the Sudbury Neutrino Observatory (SNO) relies on prompt β-γ coincidence from ^{16}N β–decay. The β–branch to the 6.13 MeV excited state of ^{16}O (66.2%) followed by deexcitation directly to the ground state accounts for more than 90% of γ-rays emitted from the source. An (n,p) reaction on ^{16}O from CO_2 is used to produce the ^{16}N. It is transfered by capillary tube to a source chamber that is lowered into the SNO D_2O. Most of the decays occur inside a thin-walled cylindrical shell of plastic scintillator coupled to a photomultiplier tube, all of which is enclosed in a stainless steel vessel. The PMT signal is used to trigger the SNO detector to observe the Čerenkov light produced from interactions between the γ-ray and e^- in the D_2O. Additional material concerning this source has been described previously in LBNL annual reports. An update on the source status is provided here.

The source chamber was tested in the underground laboratory with the complete ^{16}N production system in March. The ^{16}N decay rate was found to exceed 300 Hz, substanially higher than rates produced during tests with prototype equipment. The trigger efficiency was 95%. The source chamber and ^{16}N system are commissioned for use in the SNO D_2O.

Our calibration goal is to assign a probable energy to observed solar neutrino events. The energy will be deduced from the number of PMTs observing light (NHIT) in the event. The NHIT value will vary depending on the location of the ν interaction and the direction of the Čerenkov light. Our calibration program involves taking data with the source at numerous positions throughout the D_2O. From this data we will obtain probability distributions from which the ν energy may be deduced.

A limited ^{16}N run was undertaken to calibrate the Čerenkov photon production due to γ-ray interactions in the acrylic vessel. Early detector commissioning had occurred with an empty PMT volume, and the NHIT threshold data revealed a high energy tail at greater NHIT values than predicted by Monte Carlo simulation. The greatest background for an empty detector is the flux of γ-rays from radioactive decays in the cavity walls. The calibration was not a direct assessment of the detector response to cavity γ-rays, as that would require running the source outside the acrylic vessel, but it provided a reference to judge the the cavity γ-ray influence on the NHIT spectrum.

The calibration spectrum is compared with the standard detector runs in Figure 1. The comparison makes clear that 6.1 MeV γ-rays have an NHIT spectrum tail to 70 NHIT, therefore, the feature in the data is likely due to background high energy γ-rays.

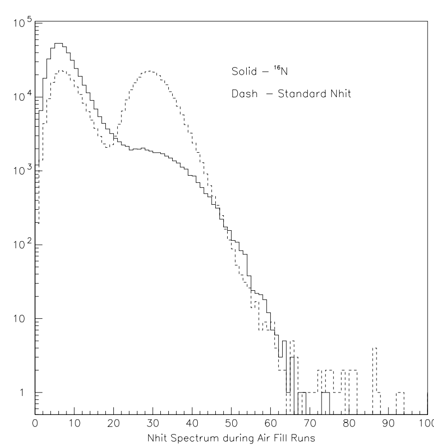

Figure 1: ^{16}N NHIT spectrum comparison.